Tanta University

Department: Elec. Computers & Control Engineering
Total Marks: 75 Marks

Faculty of Engineering

Course Title: **Control Engineering**	Course Code: **CCE3115**	Year: 3[rd] **Comp.**
Date: **24/1/2017 (First term)**	Allowed time: **3 Hours**	No. of Pages: **(2)**

Problem number (1) (17 Marks)

The open loop T.F of a system is given as:

$$GH(S) = \frac{K}{S\,(S+6)(S+8)}$$

(i) Sketch the root locus.

(ii) Determine the range of K for system stability.

Problem number (2) (18 Marks)

Consider the following open loop T.F:

$$GH(S) = \frac{10}{S\,(1+S)\left(1+\frac{S}{100}\right)}$$

(i) Sketch the bode diagram for the system.

(ii) Determine the gain margin (GM), phase margin (PM), the phase crossover frequency (wpc), the gain crossover frequency (w_{gc}).

(iii) State whether the system is stable or not.

Problem number (3) (20 Marks)

a) Explain the common classification of controllers and to what type of controllers a phase lead and a phase lag compensators belong? **(6 Marks)**

b) Consider a system with the following open loop T.F: **(14 Marks)**

$$GH(S) = \frac{K(S+2)}{S\,(S+1)(S+3)}$$

Design a suitable compensator to meet the following specifications:

- The steady-state error to a unit ramp input must not exceed 1 %
- The damping ratio of the dominant closed-loop poles is $\zeta = 0.5$
- The magnitude of the real part for the desired poles = 2

Problem number (4) (20 Marks)

a) Explain the usage of a state-feedback controller and a full order observer. **(4 Marks)**

b) Consider the following transfer function of a system, **(6 Marks)**

$$\frac{Y(S)}{R(S)} = \frac{S^2+1}{(S+2)(S-2)(S+3)}$$

(i) Obtain the corresponding state space model in controllable form and observable form.

(ii) Draw the state diagram for each form.

c) The state-space representation of a continuous system is given by: **(10 Marks)**

$$\dot{x}(t) = \begin{bmatrix} 1 & 0 \\ 0 & -0.5 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ -1 \end{bmatrix} u(t)$$

1.5 3

SI − A

$$y(t) = \begin{bmatrix} 2 & -1 \end{bmatrix} x(t)$$

$\begin{bmatrix} 1 & 1 \\ -1 & 0.5 \end{bmatrix}$ $\begin{bmatrix} 2 & -1 \\ 2 & 0.5 \end{bmatrix}$

i. Check the system controllability and observability.

ii. Find the system characteristic equation and check the system stability. −0.5 1

iii. Using pole-placement design, design a state-feedback controller to locate the closed loop poles at $S_{1,2} = -1 \pm j2$ S^2+2S+5 $\begin{pmatrix} 8 & 0 \\ 0 & 4.25 \end{pmatrix}$

iv. Design a full order observer for the above system, the observer poles are desired to have damping ratio $\zeta = 1$ and settling time (t_s) equal to one-half the settling time value of the desired poles in part (iii).

$\omega_n = 2$

$t_{s_2} = \frac{4}{1 \times 2} = 2$ $S_1, S_2 = -2$ $\frac{16}{3}$

$\frac{4}{\omega \zeta} = 2$ $\omega_n = 2$ $\frac{17}{6}$

$S^2 + 4S^2 + 4$

$\begin{pmatrix} 9 & 0 \\ 0 & 7.25 \end{pmatrix}$

Good luck

Dr. Mohammad Arafa *Dr. Mohammad Eita*

$\begin{pmatrix} 3 \\ 1.5 \end{pmatrix}$